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part without, or external to the neck, is a frustrum of a cone, while the part now within, or below the neck, is a lengthening cone, until the external frustrum wholly disappears, and the internal cone is complete; and the animal is at rest.

But little beyond conjecture can be said on the mode of use of the oral pore. It may be a sucking organ, thus imbibing nourishment. To me it seems that the entire external walls of the proboscis are functional in this direction; and during the slow inversion of this instrument, that is, while withdrawing from its hold, as each ring of hooklets is released, and involved into the crater of the returning cone, the limpid adipose flows over the crater's edge; thus the cone when returned contains a supply of nutriment. I hardly know how heterodox the view may seem to some, yet the idea presses me that the osmotic doctrine of a chemical impulsion of the nutrient fluids and gases, plays an important role in the nutritive system of these curious beings.

But my pen must stop with a confession. I must own that during the study, whose results have been given above, the so called repulsiveness of the subject was both unseen and unfelt, in the reverent sense that came upon me; so that in studying this singular organism, so lowly and so minute, with a functional structure so complete and complex, with adaptations so skilfully adjusted to a mission so mysterious — I found myself, not without emotion, repeating the sublime words of Saint Augustine: Deus est magnus in magnis, maximus autem in minimis.

NOTE.—An oral account of my discovery, with some blackboard chalking, was given to the N. Y. Lyceum of Natural History, May 12, 1869. November 14, 1871, I read a paper, giving the results of my study, before the New Jersey Microscopical Society. From that paper the principal facts given above have been taken.—S. L.

ON THE USE OF MONOCHROMATIC SUNLIGHT, AS AN AID TO HIGH-POWER DEFINITION.*

BY DR. J. J. WOODWARD, U. S. ARMY.

A FEW years ago I published, in the "Quarterly Journal of Microscopical Science" (Vol. vii, 1867, p. 253), some brief remarks

* Read before the Philosophical Society of Washington, March 9, 1872.

"On Monochromatic Illumination." These remarks were suggested by the perusal of a letter from Count Francisco Castracane published in the same journal some time before. (Ibid. vol. v, 1865, p. 249.)

Count Castracane's method consisted essentially in the use of a prism by which the sunlight was decomposed, and any selected color could be employed, blue or green seeming to him most advantageous. Mine consisted in passing the sunlight through a cell containing a saturated solution of the sulphate of copper in ammonia, which transmits a bluish violet light, admirably suited to high power definition and less fatiguing to the eye than any other color.

At the time I supposed Count Castracane's method to be new; the one I employed I ascribed to Von Baer ("Einleitung in die Höhere Optik" p. 48). I have since learned that I was in error in both particulars. The proposition to escape chromatic aberration by employing monochromatic illumination goes back in fact to a very remote period in the history of achromatic microscopes, and monochromatic lamps, as well as the use of the prism and of glasses and colored fluids as absorptive media, were early suggested. It would carry me away from my present purpose to go into a detailed history of the various attempts made from time to time in these directions. As the construction of achromatic objectives continued to improve, these devices fell into obscurity and it is only of late that attention has been directed to them anew. As for Count Castracane's method, without going further back, a full account of all the principles involved in the use of the prism for attaining monochromatic light to illuminate the microscope will be found in Chapter vii of the article on the microscope in the eighth edition of the " Encyclopædia Britannica" (American edition 1857, Boston, Vol. xiv, p. 798).

The use of the solution of the ammonio-sulphate of copper to exclude certain portions of the solar rays especially for photographic purposes, would appear to have been first suggested by one of our own countrymen more than thirty years ago.

Professor J. W. Draper published in the "Journal of the Franklin Institute" of Philadelphia, during the year 1837, a series of "Experiments on Solar Light" in the course of which several observations on the properties of the ammonio-sulphate of copper are recorded. In one of these papers (Loc. cit. Vol. xix, 1837, p.

473) he states that the ammonio-sulphate solution absorbs the red and yellow rays of the spectrum and with them so much of the heat that but "twenty rays, for every hundred that fell upon it," were transmitted.

In the London, Edinburgh, and Dublin Philosophical Magazine for September, 1840 (Vol. xvii, p. 217) the same gentleman published a paper "On the Process of Daguerreotype and its application to taking Portraits from the Life" in which he describes his attempts to reconcile the chemical and visual foci of portrait objectives, to escape "the effulgence" of the solar rays thrown directly on the sitter, as practised at that time, " abstract from them their heat and take away from them their offensive brilliancy." These are almost the very objects for which microscopists to-day resort to the copper solution. Professor Draper employed in his experiments "a large trough of plate glass, the interstice being an inch thick" filled with a dilute solution of the ammonio-sulphate. Its size was about three feet square. This was so fixed in the course of the sun's rays, reflected from a mirror upon the sitter, that his head and the adjacent parts were illuminated only by the light which had passed through the copper solution. By this device he reports he obtained excellent results.

In the spring of 1869 I received a letter from one of the sons of Professor Draper (dated April 19th) calling my attention to the above facts and transmitting several daguerreotypes of microscopic objects all bearing the marks of considerable age. These the writer (Prof. Henry Draper) states were made at various dates from 1851 to 1856. A Nachet microscope was used and in every case the ammonio-sulphate of copper is said to have been employed.

The results are not particularly good as compared with modern photomicrographs, but appear to me not much inferior to the best that could have been done by the daguerreotype method with the microscope used. The time was not yet ripe, and both microscopic objectives and photographic methods have vastly improved since those days.

My present purpose does not permit me to give greater space to these reminiscences, the real object of this paper being to indicate the best practical method to be pursued in obtaining economically the advantages of monochromatic sunlight for high power definition.

This object excludes a further consideration of the use of the

prism. It does its work admirably as I know by repeated trial, but the results are practically no better, even for photography, than those obtained by the use of the ammonio-sulphate cell, it requires greater skill to use, and the necessary apparatus is more expensive. For the same reason I shall say nothing in this article on the use of artificial lights, further than that both the prism and the ammonio-sulphate cell may be satisfactorily used with either the Calcium, the Magnesium or the Electric lights by those who are unable conveniently to secure the advantages of sunlight. The light of ordinary coal oil or gas lamps, however, is not suitable for the purpose.

Two very simple methods of securing the advantages of the ammonio-sulphate solution will now be briefly described.

(a.) I suppose the observer to be possessed of a good microscope stand, with achromatic condenser and suitable objectives. Then it is only necessary to prepare a proper ammonio-sulphate cell and fix it between the plane mirror of the instrument and the achromatic condenser. The microscope should be set near a window so that the direct rays of the sun fall on the plane mirror, while the head of the observer is protected by a convenient screen and all becomes easy.

(b.) A still better method for the resolution of lined test-objects with the highest powers, and one which is almost as simple as the foregoing is that described in my paper "On the use of Amphipleura pellucida as a test-object for high powers." (This Journal, April, 1872, p. 193.)

"Erect a perpendicular wooden screen about two feet square on one edge of a small table. Cut in this a circular hole an inch and a half in diameter at about the height of the under surface of the stage of the microscope. On the outside of this hole mount a small plane mirror which can be adjusted by passing the hand to the outside of the screen. On the inside cover the hole with the ammonio-sulphate cell." Now move the table to a window through which the direct rays of the sun can fall upon the mirror, and adjust this so as to throw the solar pencil nearly horizontally through the ammonio-sulphate cell. The mirror, and achromatic condenser, if the microscope has one, are removed and the microscope turned so that the solar pencil shall fall with the desired degree of obliquity on the under surface of the object. It will generally be best to condense the light upon the object by a small

ordinary lens, or still better by a low power objective mounted like a bull's-eye lens on a separate stand.

For prolonged observation, however, the motion of the sun will render it necessary to readjust the mirror from time to time, and the use of a heliostat becomes desirable. This gives the most satisfactory results no doubt, but the cost of the heliostat will, of course, prevent it from coming into general use except among those who desire to photograph what they observe, and the simpler methods above detailed will answer very satisfactorily for every other purpose.

The ammonio-sulphate cell used in either method should be made of two pieces of thin plate glass about two and a half inches square, held apart by thin strips of plate glass, or by a square of plate glass suitably drilled. The point is to obtain a layer of the blue solution about $\frac{1}{8}$ of an inch thick between two parallel planes of plate glass. The best cement for the purpose according to my experience is old Canada balsam applied hot; but many other devices may be employed. The solution is made by saturating strong *aqua ammonia* with sulphate of copper and should be strained or filtered so as to be free from all solid particles. A sheet of fine blue glass may be substituted for the ammonio-sulphate cell but only with tolerable results; at least, I have never had a sample of blue glass which was of just the right color.

The selection of the best condenser for high power definition is a matter which has recently elicited much discussion. In a general way I may say that any condenser will do its best work under the conditions above indicated if skilfully used. For the benefit of those who possess first class stands but have never purchased an achromatic condenser it may be stated that almost any objective suitably mounted on the secondary stage can be made to answer instead, the best results being attained when the angle of aperture of the objective thus used is rather less than that of the one employed to magnify the preparation, and when the secondary stage is capable of being centred or decentred at pleasure by screws working at right angles to each other. An ordinary low power objective (of one to three inches focal length) mounted on a separate stand and used to throw the light obliquely as already described is, however, perhaps the most convenient and efficient mode of illuminating lined test-objects with high powers.

As to the objectives suitable for monochromatic illumination,

the best compound objectives of some first class maker should be selected. It is a mistake, to suppose, as some have done, that a single lens can be substituted for the modern carefully corrected compound objective, even if the pure monochromatic light of a narrow portion of the solar spectrum as obtained by a prism were employed. For the objective always requires to be corrected for spherical aberration, and in the case of high powers must be provided with a screw collar to modify the distance between the posterior combination and the front one in accordance with the different thickness of the covering glass of the preparation. Now practically the spherical aberration is best corrected by the just combination of crown and flint glass, and combinations very nearly the same as those employed for white light would still be necessary if the objective were made for exclusive use with monochromatic illumination.

Under these circumstances I do not recommend the use of monochromatic illumination for low or medium powers except when photographs are to be made. It is only as an aid to high power definition that I here commend it. With its aid objectives incapable of resolving certain difficult tests (such as Amphipleura pellucida, Grammatophora subtilissima, etc.) with white light, show them in a satisfactory manner, and those which even with white light are capable of displaying the most difficult tests, exhibit them with greater clearness and distinctness. I attribute this result chiefly to the well known fact that the chromatic correction of our very best modern objectives is far from perfect, more or less of a secondary spectrum being always visible, and interfering with distinct vision. Moreover many of the objects we desire to examine are themselves capable of producing enough chromatic dispersion to interfere with our perception of their true form. Both these evils are escaped by the method here described. I do not advise it as a substitute for other modes of using the microscope, but as a special means of research to be reserved for occasional use in connection with the higher powers of the instrument.

I have frequently been asked to express an opinion as to whether the use of monochromatic sunlight is likely to prove injurious to the eye of the observer. On this subject I can speak from an extensive personal experience in connection with photo-micrography. The only injury to my own eyesight of which I have ever been conscious was produced by an injudicious exposure to the elec-

tric lamp. If the microscopist so manages his illuminating apparatus that the field of the microscope resembles in color and intensity the azure blue of the sky on a clear day (and this is the condition which should always be aimed at), I do not believe the use of the method for any reasonable time will be found injurious. I have recently found, when a sheet of plate glass backed with black velvet is substituted for the ordinary plane mirror in any of the above arrangements, that while the brilliancy of the light is much moderated, its desirable qualities are unchanged and it is still intense enough for the adequate illumination of the highest powers. Those who find the light obtained from the ordinary mirror too brilliant may resort to this contrivance with advantage.

SOME OF THE FAMILIAR BIRDS OF INDIA.

BY REV. H. J. BRUCE.

One is greatly surprised at the number of birds found in India. Dr. Jerdon in his "Birds of India," published in 1863, describes ten hundred and sixteen species; and since that time the list has been so much enlarged by new discoveries, that Mr. Allan Hume, in the second part of his "Rough Notes," announces thirteen hundred and sixty species as already acknowledged and identified. It cannot be supposed that this number includes all the avi-fauna of India, Burmah and Ceylon; for new species are constantly being discovered and added to the list as the number of observers is increased, and new localities are visited.

India possesses almost every variety of climate, from the snowy Himalayas on the north, to the arid plains and table-lands of the tropical south. The variety of surface, too, is very great. Whether upon the extended sea coast of several thousand miles, or upon the mountain cliffs and crags; in the immense forests of Malabar and Central India, or the thick jungles of the Ghauts and Ceylon; in the shady ravines or the open country; upon the large rivers and lakes or in the salt marshes, almost every kind of bird can find those conditions which are best adapted to its nature and wants. It is to be remembered also that this country forms the southern-